



Applications and Challenges of UAS Technologies in Tornado Damage Surveys

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Outline

- Benefits of UAS-based damage surveys
- UAS mapping & data products
- Potential applications in damage surveys
 - NWS
 - Scientific Studies
- Challenges in damage surveys



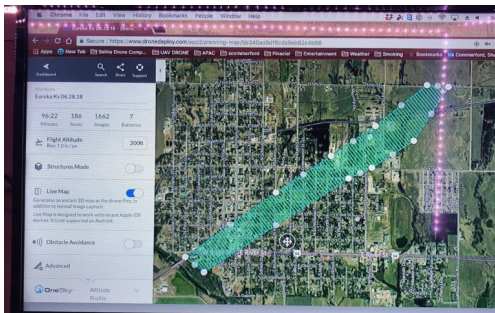
Benefits of UAS based Damage Surveys

- Address issues of accessibility (remote or impassable)
- Cost-effective Aerial Assessment
- High Resolution Imagery (centimeter scale)
- Assist with detailed site investigations and rescue efforts
- Resource Allocation
 - Priority vs. Suspect tracks in Big events



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UAS Damage Surveys – Mapping



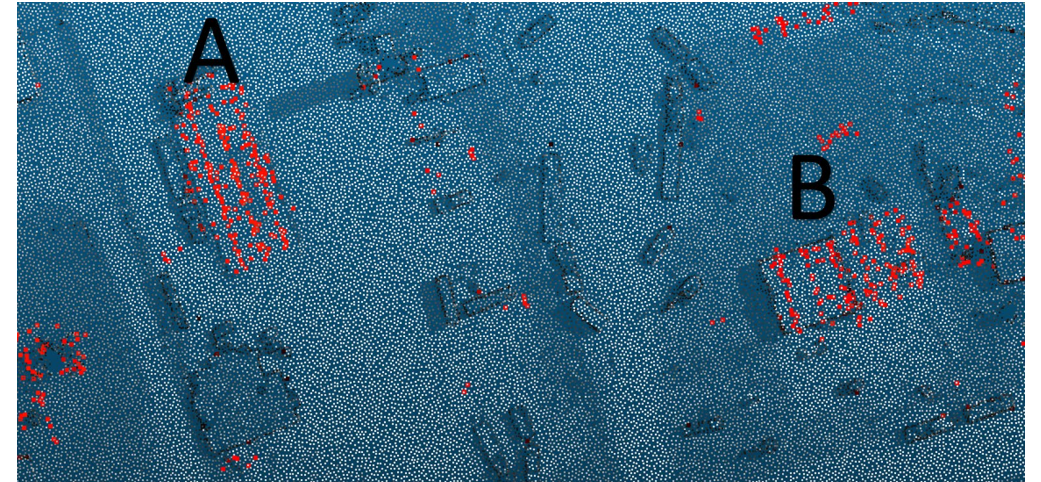
Eureka, KS Tornado June 26, 2018

UAS Damage Surveys – Mapping

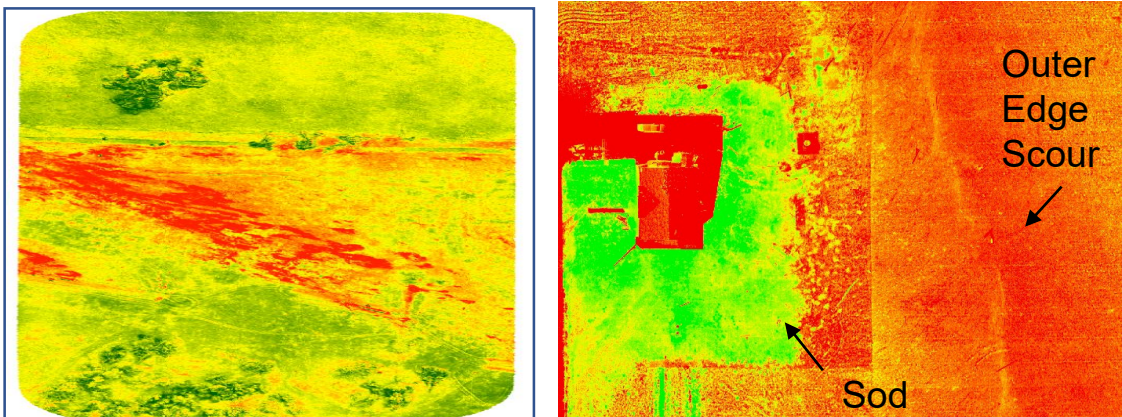
Structure from Motion
(SfM)



Change Detection – 3D Point Clouds



Multispectral Analysis (NDVI)



Applications for Improving Forecasts/Warnings

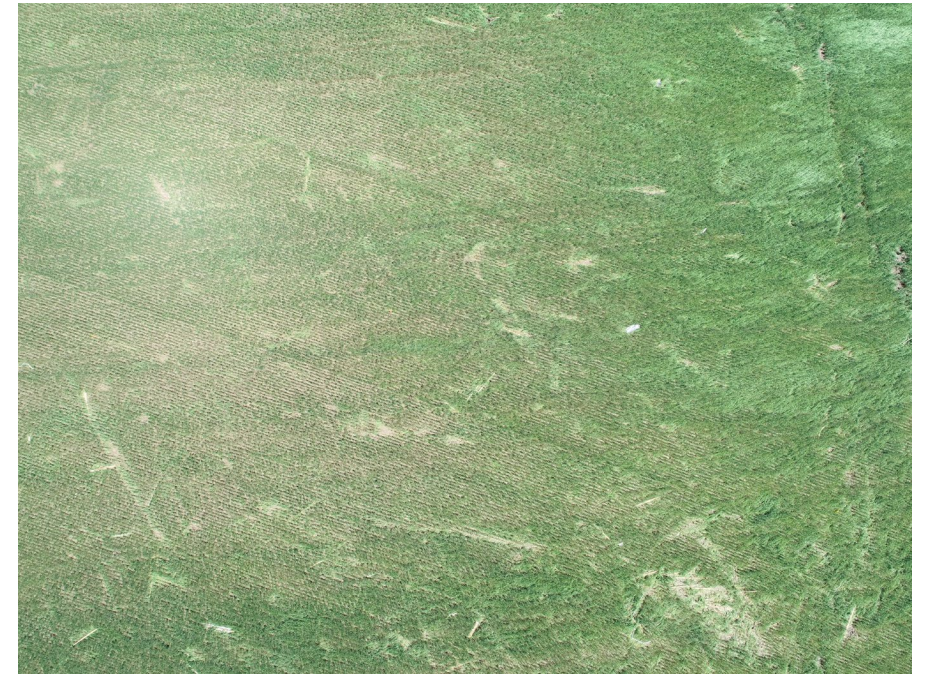
- Identify unknown damage
- Refine damage path
 - Start/End
- Augment ground surveys
 - Fill in the gaps and detailed assessment (EF-scale contouring)
 - Damage Variability
- Address arbitrary assignment of damage ratings in rural locations
- Improve accuracy of Severe-Storm-Report database



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Applications for Improving Forecasts/Warnings

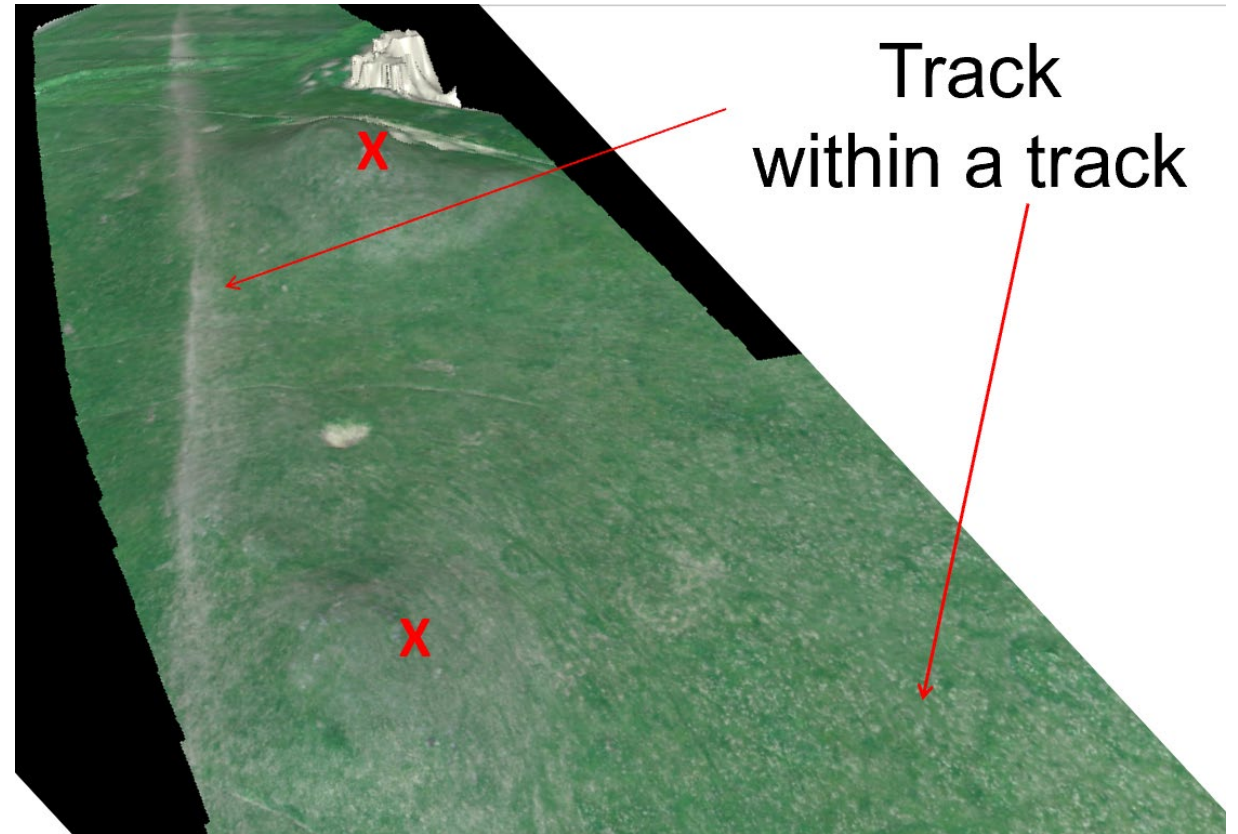
- How well modeled by radar
- Improved warning decisions & decision support services (validation, training, lead time)
- Reduce bias in the climatological record
- Calibrate high wind impacts to vegetation (GOES) in 'larger' events to National Weather Service Polar and GOES satellite imagery
- Additional DIs for vegetation that are more reflective of tornado intensity



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Applications for Scientific Study

- Storm Scale Analysis
 - Straight line winds vs. weak tornado
 - Is it Multivortex?
 - Spin up/Dissipation Stages
 - Low altitude windflow velocity and microscale processes
- Land Cover Characteristics and Tornadogenesis
 - Land Use
 - Surface Roughness
 - Pattern
 - Topography



Tescott, KS Tornado May 01, 2018

Applications for Scientific Study

- Link to Built Environment
 - Structural Design/Variability in High Winds
 - Resiliency in a Weather Ready Nation
- Link to Natural and Agricultural Environment
- More comprehensive loss
 - Socioeconomic Vulnerability & Resiliency analysis



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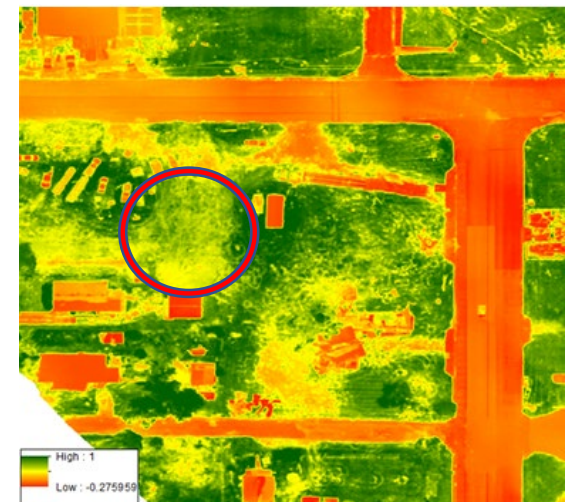
UAS Operation Considerations

- Air Space
 - Regulations
 - Special Advisories
 - Emergency operations
 - Agriculture operations
 - *Concurrent UASs Operations (Media, Sheriff)*
- Permissions
 - Agency specific policies
 - Trust in rural communities
- Collaboration with Agencies
 - Post-Event (needs and sensitivity)
 - Pre-Event (Buy-In)



Challenges of UAS Damage Surveys

- Perishable Nature of Data
 - Response time (Flight Operations) and Clean-Up
- Environmental Conditions
 - Atmospheric (Wind, Cloud Cover & Shadow)
 - Animals
- Phenological Response of Vegetation
 - Croplands
 - Trees



Challenges of UAS Damage Surveys

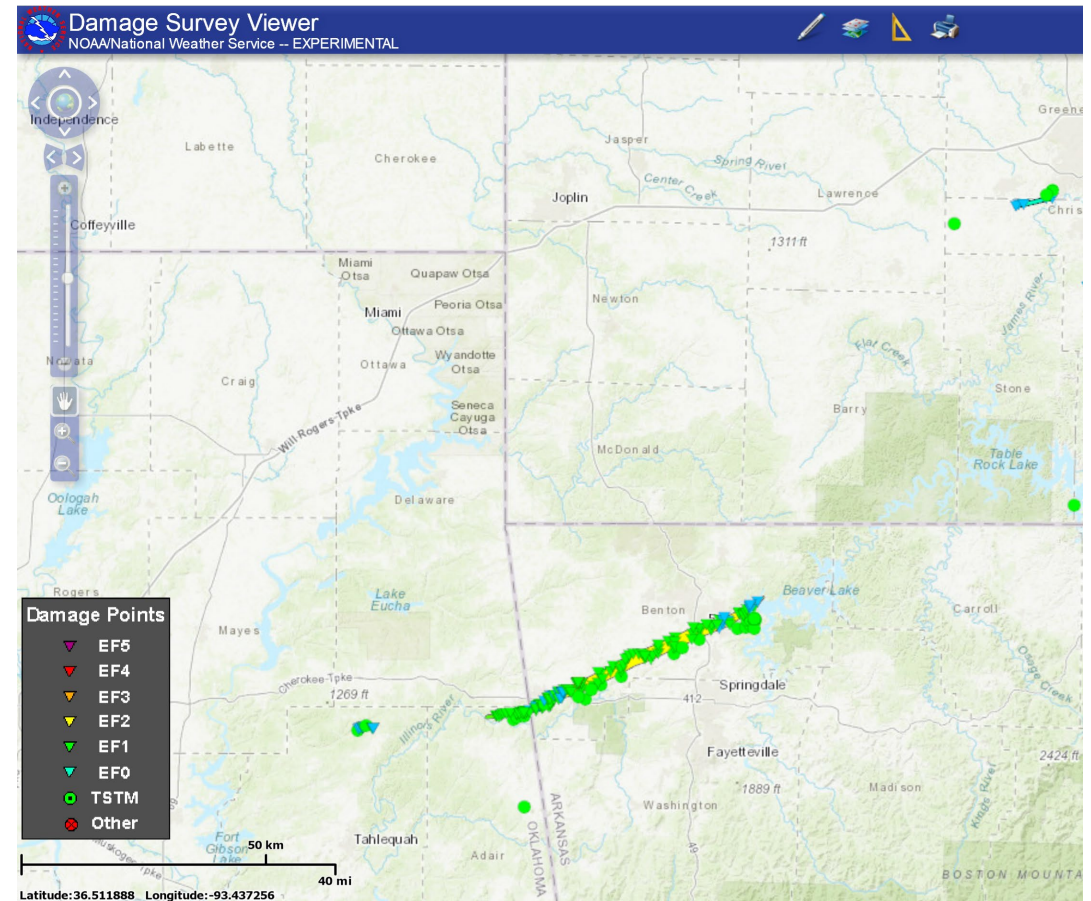
- Accessibility
 - Line of Sight
- Damage Path
 - Visual Cues & DIs
 - Probabilistic (Karstens Method)
- Scale
 - Long Track (Fixed Wing)



Canadian, TX Tornado May 23, 2019

Challenges of UAS Damage Surveys

- Data
 - Platforms (DAT) and Formats (KMZ)
 - Processing Time (Cloud Computation)
 - Organized procedure
- Technology
 - Maintenance
 - Regional vs. National Use
- Liability (Risk & Responsibility)
- Privacy Concerns
 - Citizen
 - National Security



Acknowledgements

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